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MEASURES OF INTERNATIONAL TRANSPORT COST FOR OECD COUNTRIES

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By

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ABSTRACT/RÉSUMÉ

Measures of international transport cost for OECD countries

This paper presents new estimates of country-specific international transport costs for 21 OECD countries over the period 1973-2005. The methodology is based on direct measures of air, maritime, and road transport costs rather than on cif/fob ratios or other balance of payments data employed in previous studies. Transport costs are calculated as costs per kilogramme for each mode of transport at a bilateral level and then aggregated. Australia and New Zealand are found to have the highest transport costs among the OECD countries considered, followed by Japan. The time trends are sensitive to the choice of deflator, but the results do not show an overall downward trend in transport costs for OECD countries, contrary to conventional wisdom, but consistent with Hummels' (2007) recent study of global transport costs.

JEL classification codes: F10, F14, L90, L91, L92, L93.

Key words: international trade; transport costs; maritime transport; air transport; road transport; shipping; distance; OECD.

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Les mesures internationales des coûts de transport pour les pays OCDE

Ce document présente des nouvelles estimations de coûts de transport internationaux par pays, pour 21 membres de l'OCDE pendant la période 1973-2005. La méthode repose sur des mesures directes des coûts de transport par voies maritime, aérienne et routière, plutôt que sur des ratios cif/fob ou d'autres données issues de la balance des paiements employés dans des études précédentes. Les résultats indiquent que l'Australie et la Nouvelle Zélande ont les coûts de transport les plus élevés parmi les pays de l'OCDE considérés, suivi par le Japon. Les tendances dans le temps sont sensibles au choix du déflateur, mais il n'apparaît pas de tendance globale à la baisse des coûts de transports pour les pays de l'OCDE, contrairement aux idées reçues, mais en accord avec l'étude récente de Hummels (2007) sur les coûts de transport au niveau mondial.

Classification F10, F14, L90, L91, L92, L93.

Mots-clés : commerce international ; coûts de transport ; transport maritime ; transport routier ; transport aérien ; expédition ; distance ; OCDE

MEASURES OF INTERNATIONAL TRANSPORT COST FOR OECD COUNTRIES

TABLE OF CONTENTS

Tables

Figures

MEASURES OF INTERNATIONAL TRANSPORT COST FOR OECD COUNTRIES

By Stephen S. Golub and Brian Tomasik[1]

1. Introduction

1. Globalisation is widely thought to have contributed importantly to world economic growth in both the first era of globalisation, in the second half of the 19th century, and the second era, in the second half of the 20th century. Improved transportation technology, along with trade liberalisation, is a leading candidate for explaining the expansion of world trade in both eras. In the 19th century, the increasing use of steamships and railroads was a crucial driver of global integration (North, 1958). Since the 1970s, containerisation has revolutionised maritime shipping (Levinsohn, 2006). At the same time, air shipments have become a substantial and growing mode of transport for high-value goods. In 2005, although air transport accounted for less than 1% of U.S. exports and imports by weight, in value terms air shipments represented about a third of imports and more than half of exports (US Department of Transportation, 2005). Within contiguous regions, truck transport has also been facilitated by the development of highway networks and now accounts for the bulk of exports and imports for surface transport of merchandise in Europe and North America (US Department of Transportation, 2005; KPMG, 2000).

2. These global trends may conceal considerable variation across countries, however. The extent to which particular countries can benefit from global integration depends not only on the technology of transport, but also on their geographical situation and infrastructure, as the literature on growth and development has emphasised (*e.g.* Radelet and Sachs, 1998; Limao and Venables, 2001). Countries that face high transport costs, due to distance from important markets, being landlocked, or other geographical barriers, are likely to be at a disadvantage. The goal of this paper is to ascertain the extent to which transport costs differ among OECD countries and how these differences have varied over time.

3. Despite the potential importance of transport costs as a factor conditioning economic growth, there have been few attempts to compute transport costs at the national level and over time. The usual approach to measuring country-specific transport costs is to compare the value of bilateral trade flows as reported by the exporting and importing countries and then aggregate across partner countries. In principle, the value of bilateral trade reported by the exporter is "free on board" (fob), *i.e.* does not include freight and insurance, whereas the same trade as reported by the importer includes "cost insurance freight" (cif). The available studies of international differences in transport costs, including Radelet and Sachs (1998) and Limao and Venables (2001), have mostly relied on cif/fob ratios calculated by the International Monetary Fund (IMF). The United Nations Conference on Trade and Development (UNCTAD) *Review of Maritime Transport*, the pre-eminent publication on maritime transport costs, has also resorted to comparisons of the value of bilateral trade ratios to measure national-level transport costs. Hummels and Lugovskyy (2006), however, show that cif/fob ratios are severely flawed measures both for cross-sectional and time-series analyses of transport costs, due to the lack and unreliability of the underlying trade data, which requires the IMF in many cases to impute values.

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1. Stephen Golub is Professor of Economics and Brian Tomasik is a student at Swarthmore College in the USA. This is a background paper for the OECD project on Non-Policy Determinants of Economic Growth. We would like to thank Sveinbjörn Blöndal both for inviting us to contribute to this project and for his help and comments, as well as those of Alain de Serres and Hervé Boulhol. Paul Goldsmith-Pinkham contributed helpful research assistance. All errors are our own responsibility.

4. Hummels (2007) presents various direct measures of maritime and air transport shipping costs at a global level and for a few particular countries, but no comparable country-specific direct indicators are available. In the current paper, Hummels' (2007) approach is used as a point of departure for computing country-specific maritime and air transport costs for 21 OECD countries. In addition, road transport costs are taken into account.

5. The strategy of this paper is to derive bilateral transport cost per kilogramme shipped for each of the three modes of transport and then aggregate using GDP weights over partners and transport modes. In practice, however, bilateral transport cost data are limited, requiring some simplifying assumptions. Despite the limitations of the data and method, enough information is available to put together a comprehensive data set of new transport cost estimates for the 21 OECD countries over the 1973-2005 time period. Section 2 presents the computational approach, Section 3 the data, Section 4 the results and Section 5 the concluding remarks.

2. Transport Cost Methodology

6. This section presents the method of aggregating surface, air, and maritime transport costs for each country, on the assumption that potential bilateral trade is proportional to GDP. Actual trade weights are not used in view of the likely endogeneity of trade patterns with respect to transport costs. Consider the transportation costs of an OECD country *X*. The objective is to calculate c_X, the average cost of transporting 1 kilogramme that *X* faces:[2]

$$c_X = \frac{G_X}{W_X} \quad , \tag{1}$$

where G_X is the cost that *X* faces in trading (exports and imports), and W_X is the total volume of trade in physical weight.

7. Several simplifying assumptions are made about the composition of trade by mode of transport, necessitated by the availability and quality of data. First, it is assumed that all trade that *X* does with its "neighbours" is by land.[3] "Neighbours" of *X* are defined as all OECD countries that are connected by land to *X* and are in the same continent, including *X* itself. For example, Canada's neighbours include Canada itself and the United States. Belgium's neighbours include all of OECD Europe. Japan's only neighbour is itself. Because of the large GDP shares of the United States and Europe, and the large distances involved especially in the United States and Canada, road costs matter much more for the United States and Europe than for Oceania and Japan. Second, all trade that *X* does with non-neighbours *j* will be by ocean or air, with the proportion by tonnage that is done by air being q_{Xj} and the proportion by tonnage by maritime transport $1-q_{Xj}$. The share q_{Xj} is assumed to be the same for all origin countries *X* and partner countries *j*, so all subscripts may be dropped from *q*.[4] Note that landlocked countries in Europe can engage in maritime transport by first shipping overland to ports.

2. As an alternative, costs per dollar of value shipped, *i.e.* ad valorem transport costs, were also computed. The results are also discussed briefly in section 4.4.

3. According to Hummels (2007), 90% of US trade with its neighbours is by land. Of that, the bulk is by road. There is some country-specific data on shares of road transport within Europe but the data are incomplete and sometimes implausible.

4. Calculations were made based on individual country data on *q* also, but these data displayed implausible variations and the results were not reasonable for some countries.

8. Consider first shipments to and from neighbour countries *i*, all of which are assumed to be via road. Since it is assumed that countries trade in proportion to their GDPs, the quantity that *X* transports to and from country *i* is $p_i W_X$, where p_i is country *i*'s share of world GDP. Let the cost of transporting a kilogramme of freight by road from *X* to *i* be r_{Xi}. The total costs of all of *X*'s shipments by road to its neighbour *i* is then $p_i W_X r_{Xi}$ and the total cost of shipping to all of *X*'s neighbours is

$$G_X^R = W_X \sum_i p_i r_{Xi} \ . \qquad (2)$$

9. Now consider non-neighbours *j*. *X* ships $p_j W_X$ to *j*; the amount shipped by air is $q p_j W_X$. Denote the cost of transporting a kilogramme of freight by air from *X* to *j* as a_{Xj}. The total costs of air transport that *X* faces will then be

$$G_X^A = q W_X \sum_j p_j a_{Xj} \ . \qquad (3)$$

10. Using analogous notation, with *m* representing "maritime", *X*'s total costs of ocean transport is

$$G_X^M = (1-q) W_X \sum_j p_j m_{Xj} \ . \qquad (4)$$

11. Substituting (2), (3), and (4) into (1), the average total cost of transporting 1 kilogramme that *X* faces is broken down into three contributions:

$$c_X = \frac{G_X}{W_X} = \frac{G_X^R + G_X^A + G_X^M}{W_X} = \sum_i p_i r_{Xi} + q \sum_j p_j a_{Xj} + (1-q) \sum_j p_j m_{Xj} \ . \qquad (5a)$$

Equation (5a) provides a formula for aggregating the costs of the three alternative modes of transport. The bulk of the effort in devising average transport costs is focused on obtaining a panel data set of the bilateral measures r_{Xi}, a_{Xi}, and m_{Xi}, the costs per kilogramme of shipping by road, air, and sea, for each country *X*. The contribution of each of these unit costs is then found by weighting the unit costs by partner country GDP p_i for neighbours and p_j for non-neighbours. Given that $\sum_i p_i + \sum_j p_j = 1$, the total average cost per kilogramme, c_X, can be expressed as a weighted average of the average cost per mode of transport, c_X^R, c_X^A and c_X^M:

$$\begin{aligned} c_X &= \left(\sum_i p_i\right) \frac{\sum_i p_i r_{Xi}}{\sum_i p_i} + \left(q \sum_j p_j\right) \frac{\sum_j p_j a_{Xj}}{\sum_j p_j} + \left((1-q)\sum_j p_j\right) \frac{\sum_j p_j m_{Xj}}{\sum_j p_j} \\ &= \left(\sum_i p_i\right) c_X^R + \left(q \sum_j p_j\right) c_X^A + \left((1-q)\sum_j p_j\right) c_X^M \end{aligned} \ . \qquad (5b)$$

3. Data and Computations of Transport Costs

12. Transport costs were calculated for 21 OECD countries over 1973-2005. The 21 countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

13. For air and road transport, outbound (export) and inbound (import) costs are not distinguished. Partial data indicate that inbound and outbound air transport costs sometimes differ, but there is insufficient data to analyse them separately. For road transport, there is little basis for distinguishing between inbound and outbound costs since road transport is confined to within-neighbour transport, where rates are unlikely to differ much, *e.g.* between European countries. In the case of maritime transport costs, however, both outbound and inbound rates are computed.

3.1. GDP Weights

14. Real GDP weights were used to aggregate bilateral transport costs into country totals for each mode of transport. GDP data for each of the 21 OECD sample countries, as well as for regional aggregates of the rest of the world, were obtained from World Bank *World Development Indicators*. The 4 non-OECD regions considered were Eastern-Central Europe, South Asia, East Asia and Latin America. This, combined with the OECD countries themselves, covered 97% of world GDP. Real GDP values at the market exchange rate were used rather than PPP-based measures of GDP. For the OECD countries, the choice of market versus PPP exchange rates made very little difference, but it had an important bearing on the shares of non-OECD regions. PPP exchange rates seemed to give excessively large weights to non-OECD countries.

15. All European countries are assumed to be "neighbours," as are the United States and Canada, and Australia and New Zealand.[5] Japan does not have any neighbours except itself. The GDP share, $\sum_i p_i$, of neighbours in 2004 is shown in Table 1.

Table 1. Share of "Neighbours" in World GDP, 2004

Per cent

Europe	27.0
USA and Canada	35.1
Australia and New Zealand	1.5
Japan	15.0

3.2. Air Transport

16. In computing air transport costs, the data sets employed were the same as used by Hummels (2007), namely ICAO for 1973-1993 and the United States Bureau of Labor Statistics (BLS) for 1994-2006. ICAO reports air freight costs for selected city-pair routes within specified regions (*e.g.*

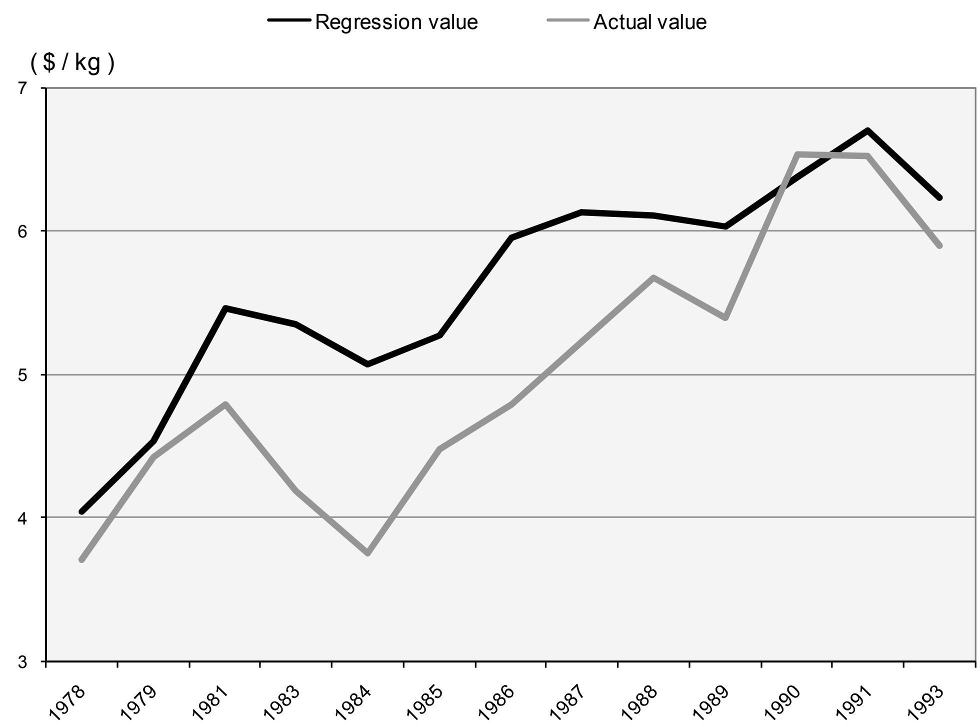
5. This assumption is of course not correct for Australia and New Zealand, but has an insignificant effect on the computations given the small GDP shares of each of these two countries. Also, Ireland and the United Kingdom are not exactly land-neighbours for the rest of Europe, but the distances to be covered by sea to reach continental Europe are small.

London to New York within the North America–Europe region, London to Zurich in the intra-Europe region, Tokyo to Paris in the East Asia–Europe region, etc.). ICAO used a large number of bilateral rates to compute regression coefficients by region for each year. The regression is specified with cost as a nonlinear function of the bilateral distance D_{Xj} between X and j:

$$a_{Xj} = \alpha D_{Xj}{}^{\beta} \; . \tag{6}$$

17. The regression coefficients α and β in equation (6) differ by region.[6] In order to estimate D_{Xj}, distance measures were taken from CEPII data on Geodesic Distances. CEPII provides distances between every pair of countries (including a country to itself) using a population-weighted average of distances to the 25 largest cities in each country, in addition to the capital-to-capital distance. CEPII's "distances" series is used for inter-country distances. 18. ICAO's regression coefficients were applied to the inter-country distances, for each bilateral OECD country pairing as well as with the other 4 major non-OECD regions of the world. This provided an estimate of bilateral air transport costs for each of the OECD countries for 1973-1993 with 20 partner OECD countries and 4 non-OECD regions. Figure 1 compares the computed costs based on a regression and the actual rates for the London-New York route, one of the few routes reported directly in most of the annual ICAO publications. Figure 1 illustrates that the regression method yields similar results to the actual rates. All air costs are expressed in current dollars per kilogramme shipped.

Figure 1. Regression *vs* actual cargo rates for London to New York



Source: ICAO and OECD calculations.

6. If $\beta = 1$ the cost is linear in distance. For the most part β is close to but not identical to 1. Overall the results would not have been very different if costs had been assumed to be linear with distance.

19. For 1994-2006, all 1993 costs computed using the ICAO data were extended with BLS air-freight indexes for the United States, as in Hummels (2007).[7] BLS reports an index of air freight costs for US-Europe and US-Asia, for both inbound and outbound directions. To update the US-Japan and US-Australia routes, the US-Asia BLS index was used. Likewise the US-Europe routes were updated based on the US-Europe BLS index, and all other routes were updated with the average world index values that BLS also provided.

20. The GDP weights for all non-neighbours *j* were then used to obtain average air transport costs for each OECD country, *i.e.*, $\sum_j p_j a_{Xj} / \sum_j p_j$. The calculations include GDP weights for non-OECD partner regions. In particular, East Asia's rising share of world GDP slightly lowered Japan's relative transport costs over time due to Japan's proximity to China and other East Asian countries. For other OECD countries' air transport costs, inclusion of non-OECD partners had minimal effects.

3.3. Maritime Transport

21. Bilateral maritime transport cost measures for manufacturing goods by origin and destination country are sparse.[8] As the measure of international maritime transport costs, the cost of shipping a twenty-foot container (TEU) is used. For most OECD countries, exports are dominated by manufactured goods rather than commodities, so the focus on containerised shipping is appropriate. Australia and Canada, however, are major exporters of bulk commodities such as wheat, coal and iron, so the measure reported here may be less meaningful for these two countries, but was nonetheless chosen as the best available standard indicator across countries.

22. Container transport cost data were obtained from UNCTAD's *Review of Maritime Transport* (RMT) on the three major transatlantic routes (those connecting Europe, North America, and Asia, in both directions) for 1995-2006.[9] Various maritime freight price indexes were used to extrapolate backwards from 1995 to 1970. The US Bureau of Labor Statistics has a series extending back to 1990, and a maritime freight cost index for electronic goods starting in 1985 was obtained from the Japanese government. The longest available series is the German index published by RMT and used by Hummels (2007). The latter was used to backcast all series when no other data were available.

23. The cost of maritime shipping per kilogramme was converted from cost per TEU (a measure of volume) using the average weight of a container at West Coast ports in the United States in 1999 (Pacific Maritime Association 1999).

24. No internationally comparable data are available for Australia and New Zealand container shipping costs. Australia's and New Zealand's costs were assumed to exceed Japan's by a factor reflecting the fact that these countries are farther from the United States and Europe than is Japan. The simple

7. Numerous inquiries were made to other organizations such as the International Air Transport Association (IATA) to obtain more detailed data for the post-1993 period, but they met with no success.

8. For bulk commodities, the Baltic Exchange Index provides information about the development of transportation costs.

9. Bilateral rates are also available from Maersk's web site, but not in a systematic or consistent manner, rendering comparisons across countries and over time difficult. Various other private companies were also contacted, as were other possible sources such as the trade journal *Containerization International*, government agencies, and individuals, but more detailed disaggregated information across countries and over time is not available from any of these sources. *Containerization International* appears to be the source of the UNCTAD data.

average distance differential was found to be about 1.3, *i.e.* maritime costs for Australia and New Zealand were assumed to exceed Japan's costs by a constant rate of 1.3.[10]

25. Maritime costs were also assumed to be the same for all countries within each region, *e.g.* the costs were assumed to be the same to ship from the United States to any point in Europe and vice versa. This assumption is necessitated by lack of data but is also partially corroborated by the limited existing information, *e.g.* from Maersk's web site.

26. Each region's average maritime transport cost was computed as the weighted average $\sum_j p_j m_{Xj} / \sum_j p_j$, where GDP weights p_j are now aggregated at the level of the four OECD regions (North America, Europe, Asia, and Oceania) rather than by country.[11] These calculations were undertaken separately for exports and imports.

3.4. Road Transport

27. As explained in the preceding section, road transport is assumed to take place between "neighbours" only. Road costs per kilogramme are computed as the cost per kilogramme per kilometre multiplied by the distance between each pair of neighbours using the CEPII data described in section 3.2.[12] Road cost per kilogramme per kilometre is obtained from the United States Department of Transportation for 1990-2000.[13] For other years, US road transport cost is extrapolated backwards and forwards using the US GDP deflator.[14] Europe's road costs per kilometre were taken to be 1.4 times those of the United States, based on a study by KPMG (2000) comparing US and European road transport costs. For Japan and Oceania, road transport costs per kilometre were assumed to be the same as in the U.S. in the absence of any other country-specific data. Average road transport cost is obtained using neighbour GDP weights: $\sum_i p_i r_{Xi} / \sum_i p_i$.

10. It turns out that this 1.3 ratio is nearly identical to the ratio of Australian to Japanese air transport costs that was obtained, providing some corroboration of the validity of this approximation.

11. Asia's weight was adjusted to reflect the rising share of developing countries in East Asia in world GDP (mainly attributable to China). No other non-OECD regions were considered due to lack of data on regional maritime transport costs. Given the relative lack of importance of these other regions for air transport costs noted in section 3.2, however, this is unlikely to have a significant effect on the results for maritime transport.

12. Intra-country distances for the road transport computations are based on surface areas. The underlying assumption behind the internal distance $d_{ii} = 2/3\sqrt{area_i / \pi}$ is that a country is a disk where all suppliers are located in the center and consumers are located uniformly over the area.

13. See US Department of Transportation (2000). Values for cost per truck per kilometre were taken from p. 21. The average weight of a truckload was taken from p. 27. Other sources of information yielded similar magnitudes for US road transport costs per kilometre, notably Maersk's web site and a World Bank (undated) study.

14. An oil price index was also experimented as an alternative to the GDP deflator for extrapolating road costs. However, the GDP deflator correlated much better with the actual numbers over the period 1990-2000.

3.5. Total Average Transport Cost

28. Total average transport costs are computed as a weighted average of the road, air and maritime average transport cost per kilogramme using the results from the 3 modes of transport, as shown in equation (5b). The share q of non-neighbour trade expressed in weights by air versus sea, assumed to be the same for all countries as noted in section 2, is based on Hummels (2007). It varies from 0.36% in 1973 to 0.85% in 2005.

29. Recall that $\sum_i p_i + \sum_j p_j = 1$ where i and j represent "neighbour" and "non-neighbour" countries, respectively. The contributions of air and maritime transport cost to total average cost for country X therefore depend both on the share of non-neighbours $\sum_j p_j \leq 1$ for X in world GDP, and the costs of shipping by air and sea to each of these non-neighbours. For Oceania and to a lesser extent Japan, "neighbours" account for a small share of world GDP, so road transport has a much smaller weight in overall transport costs than in Europe and North America. $\sum_j p_j$ is close to 1.0 for Oceania and averages around 0.65 for the United States and Europe and 0.85 for Japan.

30. Two alternative deflators are used to convert nominal transport costs to real terms: US GDP deflator and US manufacturing sector deflator. The latter is a better indicator of tradable goods prices for OECD countries since most exports of OECD countries are manufactures. US price indexes were used since all the transport cost variables are computed in US dollars.

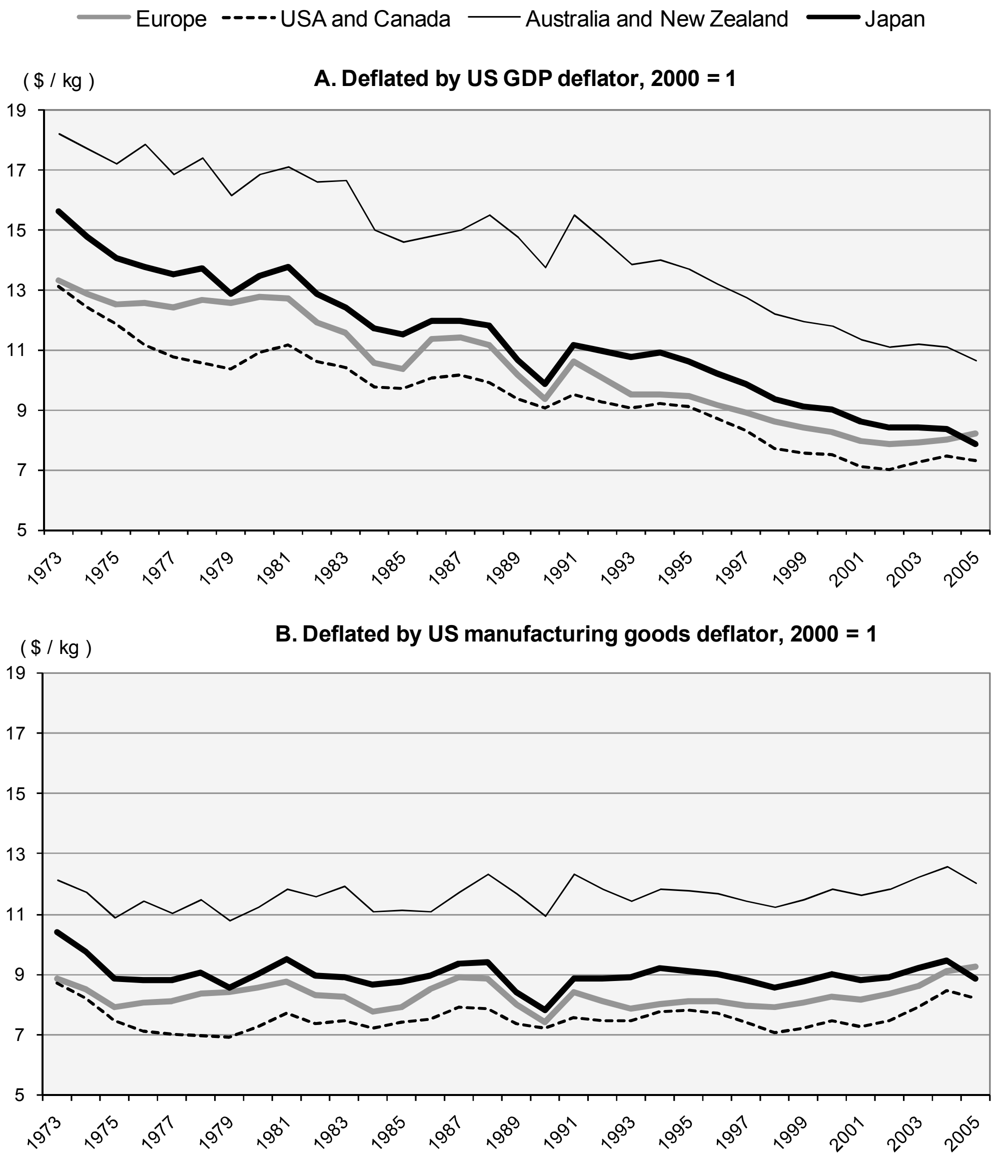
4. Transport Cost Results

4.1. Air Transport

31. Based on equation (5a), the air transport cost contribution to total average cost is $q\sum_j p_j a_{Xj}$, *i.e.* q times the sum of the product of the share of each non-neighbour j in world GDP, p_j, times the average cost of shipping 1 kilogramme by air to that non-neighbour a_{Xj}, measured in US dollars. This contribution reflects both the relative importance of non-neighbours and bilateral air transport costs.

32. Figure 2 presents the real average air transport cost per kilogramme $c_X^A \equiv \sum_j p_j a_{Xj} / \sum_j p_j$

Figure 2. Average air transport cost



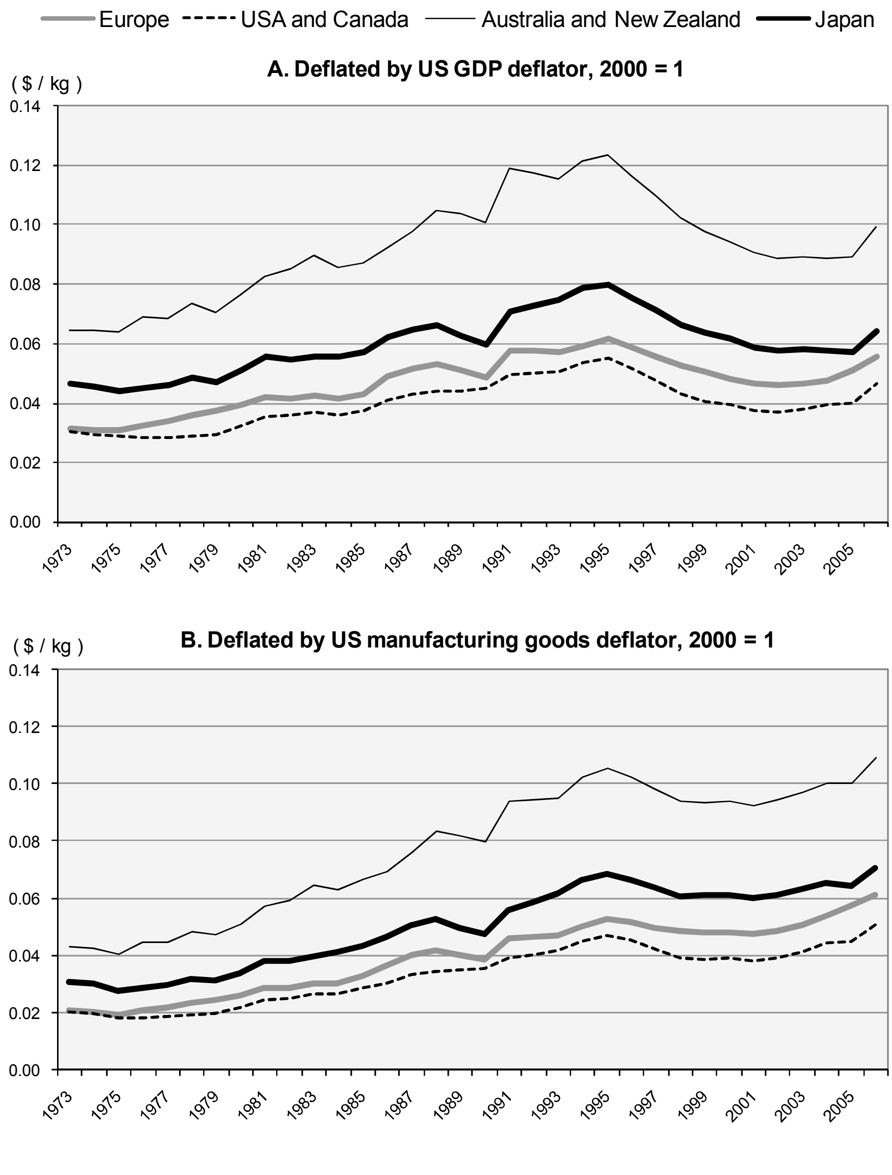
Source: ICAO, BLS and OECD calculations.

for the four "regions": Australia-New Zealand, Europe, Japan, and the United States-Canada, expressed in 2000 US$ per kilogramme. Real average air transport costs exhibit a general downward trend for all regions over the 1973-2005 period when deflated by the US GDP deflator. When the US manufacturing deflator is used, however, real air transport costs hardly changed over the 1973-2005 period, reflecting lower price increases in manufacturing than for the overall economy.

33. The contribution of air to total average transport cost, represented in Figure 3, shows a different pattern due to the sizeable increase in the share *q* of trade by air versus sea. For instance, using the GDP deflator, the air contribution has increased by 40% on average over the sample period, even though the average air transport cost has dropped by half. Moreover, Oceania's air transport cost contribution is consistently much higher than that of the other regions. This reflects primarily Oceania's greater distance

to major destinations, leading to high c_X^A; it also to a lesser extent reflects the fact that $\sum_j p_j$ is close to 1.0 as noted in section 3.5. Japan's air transport cost contribution is above that in North America and Europe due to these same considerations. The air transport cost contributions in Europe and North America are quite similar.

Figure 3. Air contribution to total average transport cost



Source: ICAO, BLS and OECD calculations.

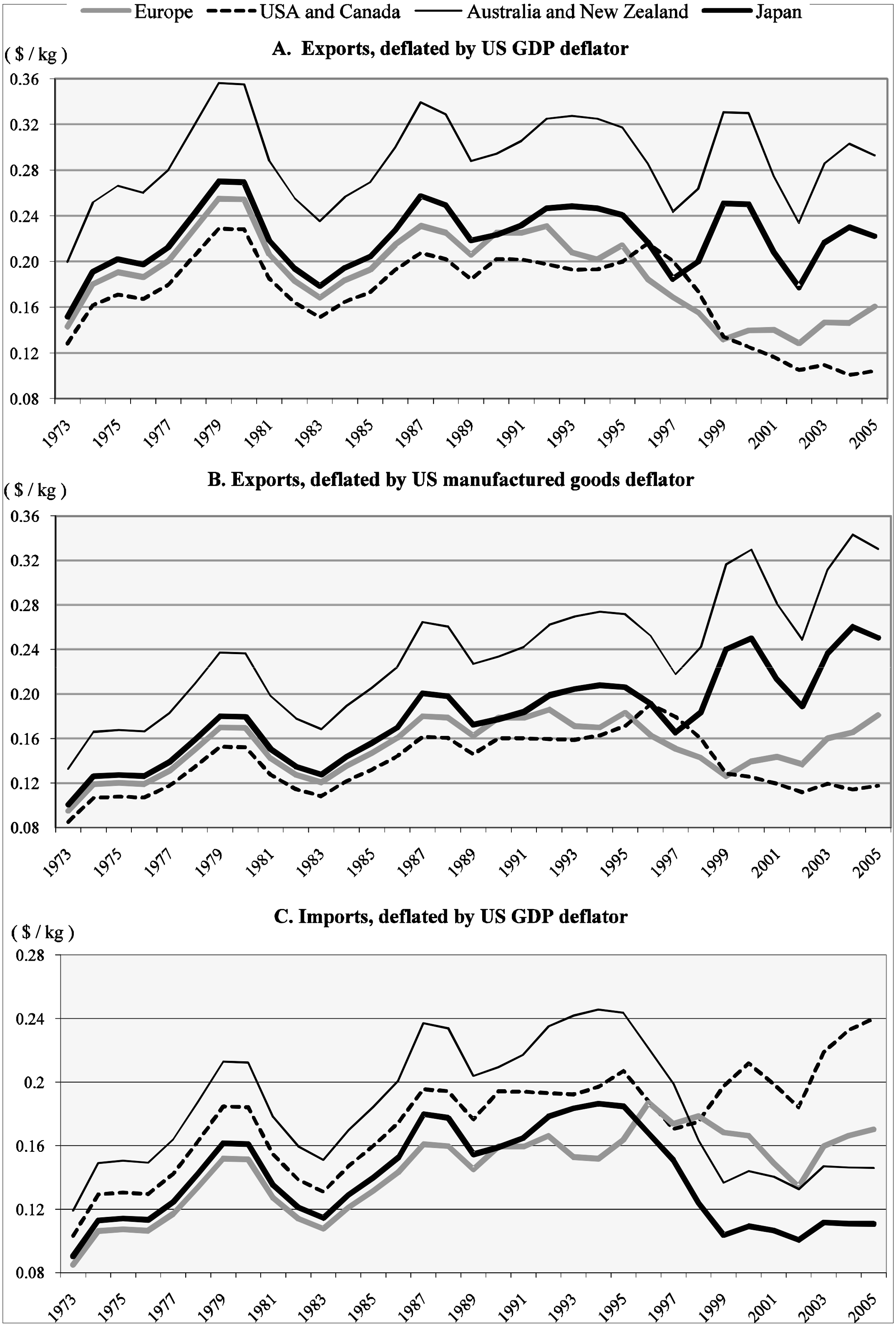
34. There is little country variation within each region, *e.g.* air transport costs are very similar for all individual European countries. This reflects the geographical proximity of European countries to each other relative to other destinations, and the use of the same regression coefficients for all European countries relating cost to distance. The ICAO regression equations were specific only to the level of continental route groups, so countries in the same route group can only differ to the extent that their distances to other countries vary.

4.2. Maritime Transport

35. Analogously to air transport, the maritime transport cost contribution of total costs is $(1-q)\sum_j p_j m_{Xj}$, where m_{Xj} is the cost of shipping 1 kilogramme to non-neighbour j. Again, the relative importance of non-neighbours and the cost of shipping by destination both enter into the contribution of maritime transport to total costs. As explained in section 3.3, the data for maritime transport costs are less complete than for air transport, with strictly comparable cross-continental data from UNCTAD only available from 1995 to 2006 along with partial country-level data back to 1985, and that only for the major transatlantic routes involving North America, Europe and Japan. There are no internationally comparable data on Oceania. Therefore Oceania's m_{Xj} were estimated, as described in section 3.3. The cost of shipping to and from other East Asian destinations is also assumed to be the same as to and from Japan, and Asia and Japan are used interchangeably in the discussion that follows.

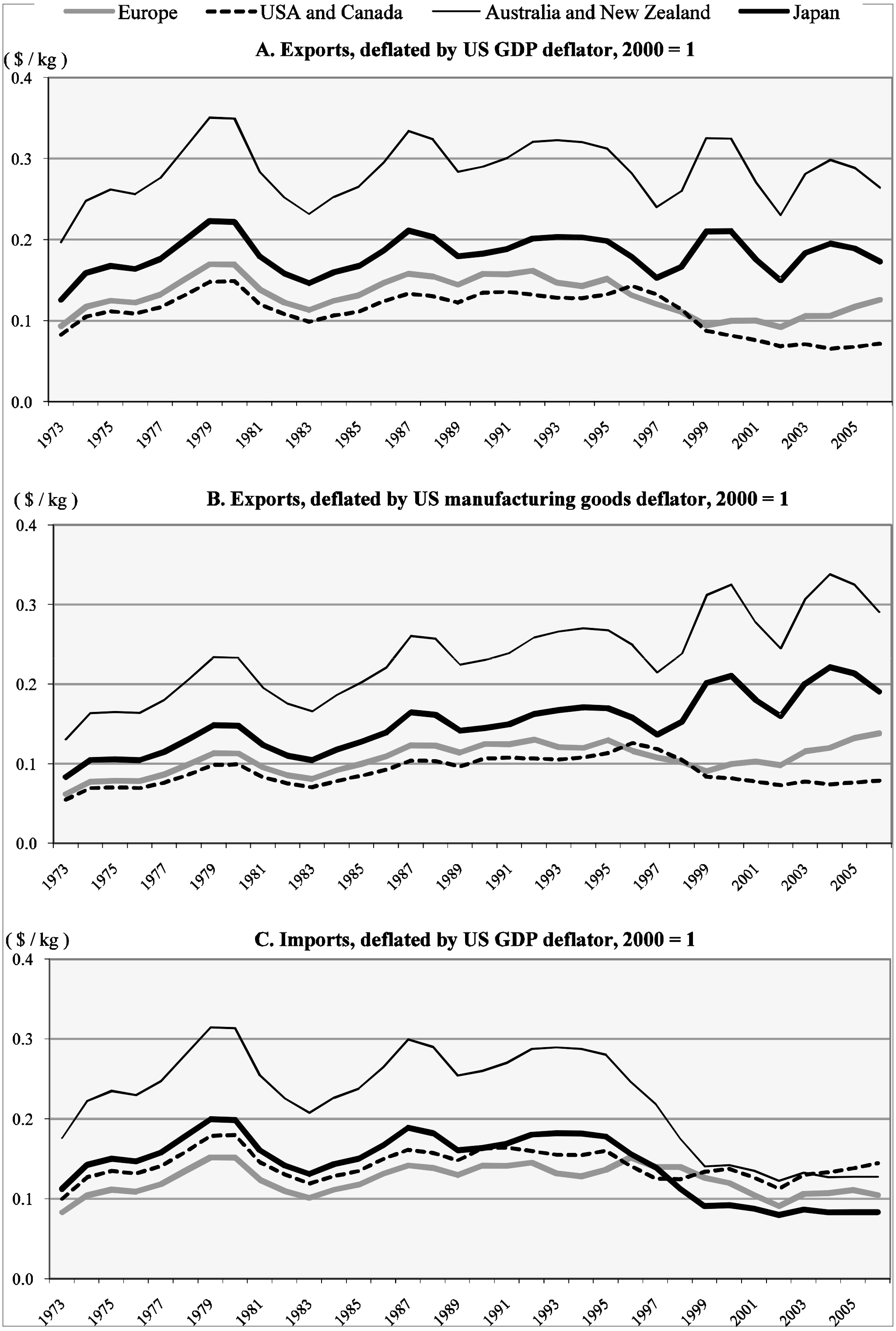
36. Figure 4 plots the average maritime transport cost per kilogramme and Figure 5 displays the maritime cost contributions by region, both using alternative deflators and broken down by outbound versus inbound. Comparing Figures 2 and 4 reveals that transporting 1 kilogramme by air is 40 to 60 times more expensive than by sea.

Figure 4. Average maritime transport cost



Source: UNCTAD, BLS and OECD calculations.

Figure 5. Maritime contribution to total average transport cost



Source: UNCTAD, BLS and OECD calculations.

37. In the case of outbound shipping (Figures 4, Panels A and B, and 5, Panels A and B), Japanese maritime export costs exceed those of North America and Europe, for reasons similar to those described for air transport costs. Maritime transport costs, however, are much more volatile than air transport costs. Maritime transport costs are also very sensitive to the direction of shipping; in recent years, costs of shipping from Asia to Europe or Asia to North America have been about double the respective costs of shipping from Europe to Asia and North America to Asia. Figures 4, Panel C and 5, Panel C show the results for inbound instead of outbound traffic; in this instance Japanese costs fall below those of Europe around 1997. The high variability of maritime shipping cost over time and by destination may reflect the short run inelasticity of supply and demand for container shipping.[15] The rising cost of shipping from Asia to Europe and North America since the late 1990s probably reflects booming Chinese exports, and the rising Chinese trade surplus, which have been driving up the price of container shipping from Asia relative to the price of shipping to Asia. By construction, Oceania's shipping costs exceed those of Japan by a factor of 1.3 for both inbound and outbound traffic, and are therefore generally the highest.

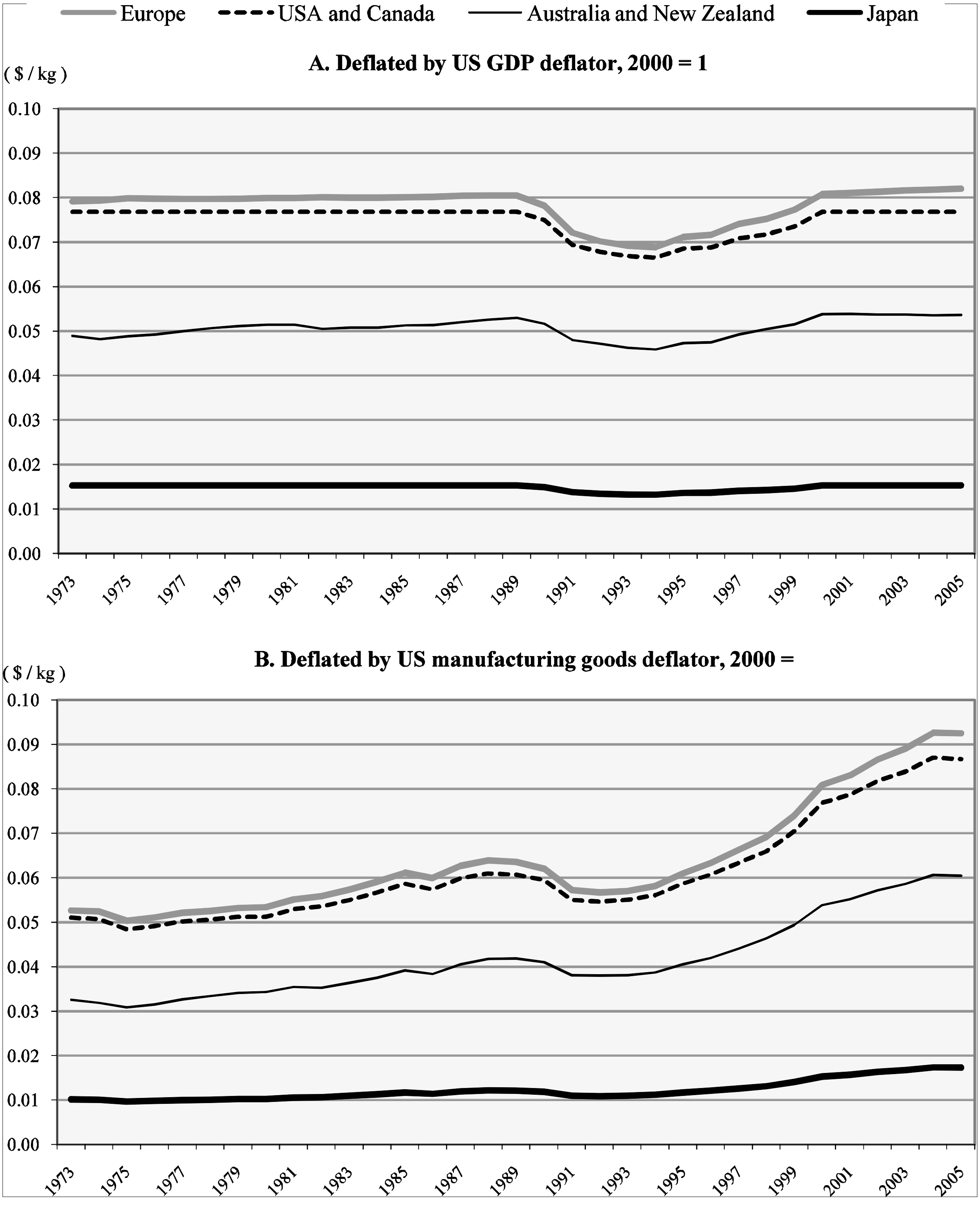
38. When the GDP deflator is used to convert to real terms, maritime shipping costs display marked fluctuations but no clear trend, but with the manufacturing deflator, real maritime shipping costs tend to rise over time, especially for Asia and Europe.

4.3. Road Transport

39. In contrast to air and maritime transport, road transport is based on trade with neighbours *i* only: $\sum_i p_i r_{Xi}$, where r_{Xi} are road costs per kilogramme for shipping from country *X* to neighbour country *i*. The average road cost per kilogramme is $\sum_i p_i r_{Xi} / \sum_i p_i$. Following the same rationale as in the preceding sub-sections, Figures 6 and 7 display the average road transport cost per kilogramme and the contribution of road costs to total transport costs, respectively.

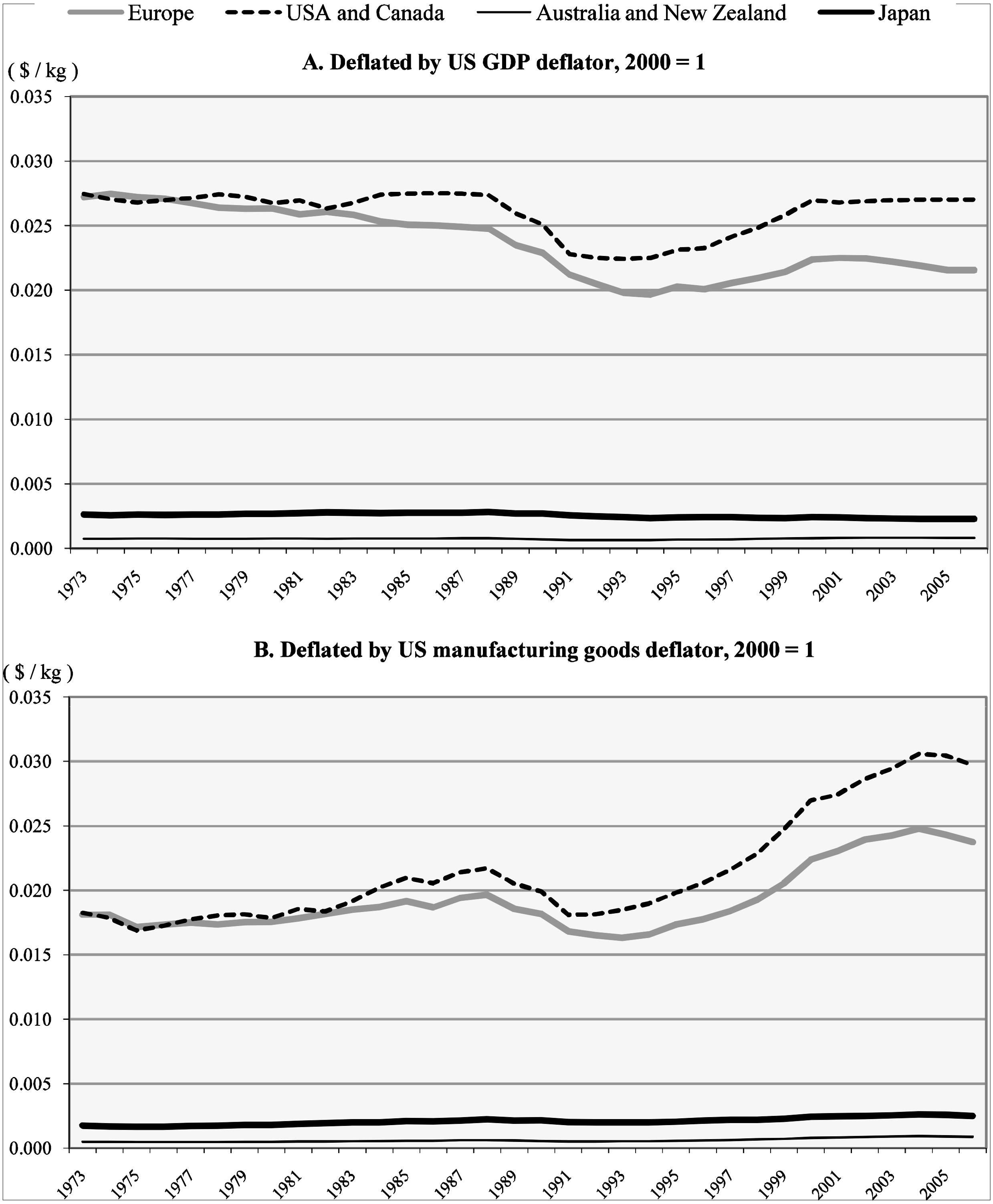
15. The high correlation observed before 1985-1990 in the fluctuations by region reflects the fact that there is no country-specific data before then. US maritime price indexes go back to 1990 and Japanese data to 1985. All other data are backcast using the German index reported by Hummels (2007). Also, of course, the perfect correlation of Japanese and Australian costs is by construction.

Figure 6. Average road transport cost



Source: US Department of transportation, KPMG and OECD calculations.

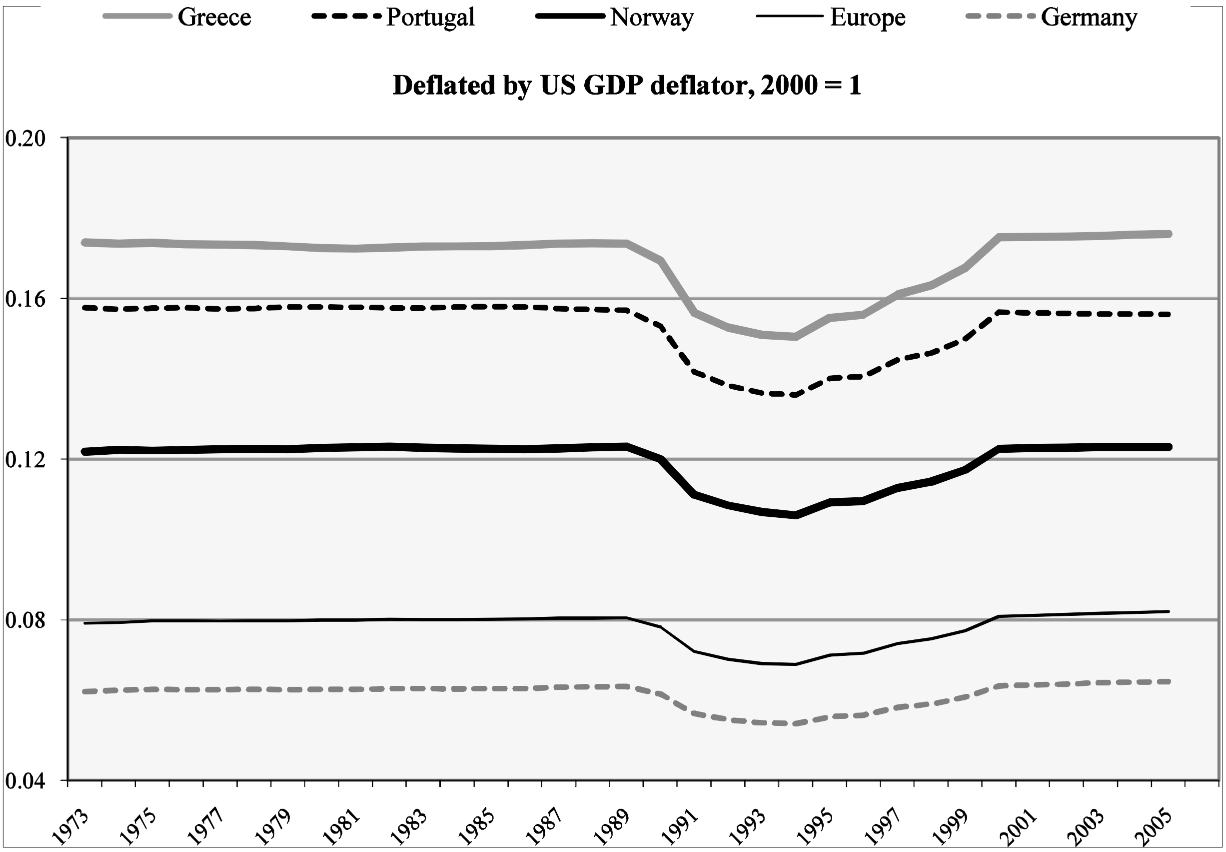
Figure 7. Road contribution to total average transport cost



Source: US Department of transportation, KPMG and OECD calculations.

40. The average road transport cost c_X^R is the product of the average cost per kilometre and the distance between neighbours, including the internal distance within countries. The contribution is that average times the share of neighbours in world GDP, summed over all neighbours: $\left(\sum_i p_i\right) c_X^R$. Figures 6 and 7 illustrate the very minor importance of road transport costs for Japan and Oceania relative to North America and Europe. This manifests the much larger share of neighbours in European and North-American GDP and also, especially in the case of North America, the greater distances to be covered for intra-neighbour transport. European and North-American road transport costs are very similar, reflecting several considerations: 1) the economic sizes of the two regions are roughly equal, 2) European road costs per kilometre shipped are estimated at 40% above those of North America, but 3) the distances to be covered in North America are larger, *i.e.* population density is higher in Europe, lowering cost per kilogramme shipped, *ceteris paribus*. Conversely, the fact that Japan has lower average road transport cost than North America is entirely due to its relatively small size, as the cost per kilometre is assumed to be the same. The even lower road contribution for Japan relative to that of North America reflects the fact that "neighbours" have a lower world GDP share for Japan (see Table 1). Again, the choice of deflator affects the trend over time but not the inter-regional differentials.

Figure 8. Average road transport cost in selected European countries



Source: US Department of transportation, KPMG and OECD calculations.

41. Within Europe, road transport costs vary considerably, as shown in Figure 8 for selected European countries. Countries such as Germany, France, Belgium and the Netherlands have relatively low road transport costs, below those of Europe as a whole, but countries on the outer edges of Europe, such as Portugal, Greece and the Nordic countries have road transport costs above the European average. This reflects the variations in the GDP-weighted distance to travel to the heart of Europe, where the bulk of European GDP is located.

4.4. Overall Results

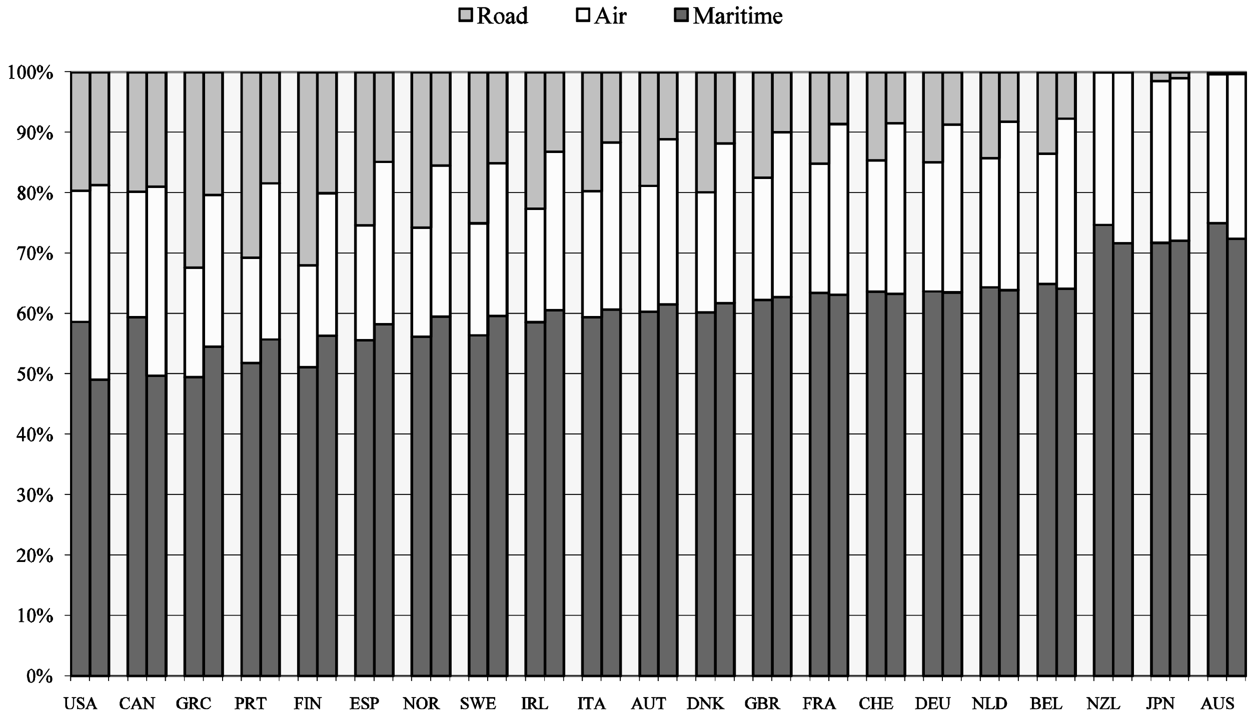
42. This section presents the results for total average transport cost by region, aggregating the contributions of the three modes of transport. Unless specified otherwise, the results are based on outbound (export) transport costs for maritime transport. The aggregation method is based on equation (5a) in the methodology section:

$$c_X = \sum_i p_i r_{Xi} + q \sum_j p_j a_{Xj} + (1-q) \sum_j p_j m_{Xj} \quad .$$

43. The contributions of the three modes differ somewhat between countries, due to the variance in the economic size of neighbours. The contributions to cost also depend on the relative costs per kilogramme, a_{Xj}, m_{Xj}, and r_{Xi} . a_{Xj} is much higher than the other two, *i..*, air transport cost per kilogramme is very high, but the share of air transport q is low, although rising over time. q is currently still less than 1% of world non-neighbour trade by weight, but air transport cost per kilogramme is 40-60 times greater than that for maritime transport.

44. Figure 9 shows the shares of total average cost by mode of transport in 1973 and 2005 by country. Maritime transport in 2005 accounts for the bulk of transport costs ranging from about 50% of costs for the United States and Canada to a high of about 70% of total costs for Oceania. For most countries, the share of costs attributable to maritime transport has shown little change since the early 1970s, except for the United States and Canada which experienced declines of close to 10 percentage points. Air transport costs currently represent about 25-30% of total costs, up by between 5-10% points for all countries since the early 1970s. The rising share of air transport in total costs reflects the fact that the volume of air shipments has increased proportionately more than the cost of shipping by air has fallen. The share of road transport is more variable, representing less than 1% of total costs for Oceania and Japan to around 20-30% for the United States, Canada, and European countries.

Figure 9. Shares of transport cost by mode of shipping in total average cost (export), 1973 and 2005

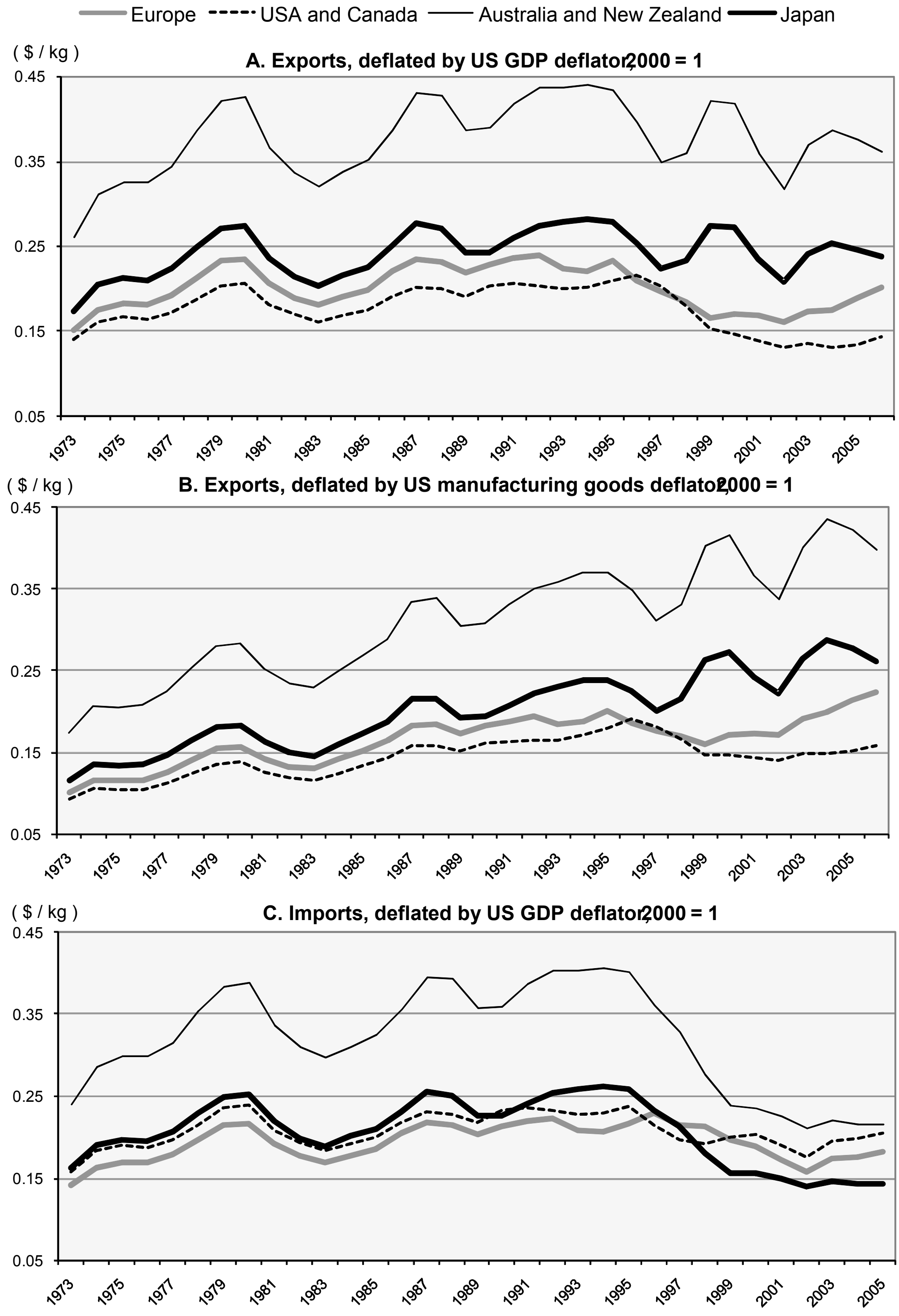


1. Data for the year 1973 are represented in the first column of each country, data for the year 2005 in the second column. Data have been sorted on the maritime transport cost for 2005.

Source: OECD calculations.

45. Figure 10 presents total average transport cost by region and varying by type of deflator and direction of traffic. Oceania's costs are by far the highest. North American and European transport costs are generally fairly similar, although the former decline relative to the latter starting around 2002. These trends are mostly driven by maritime transport cost developments, given their preponderance in the weighting.

Figure 10. Total average transport cost

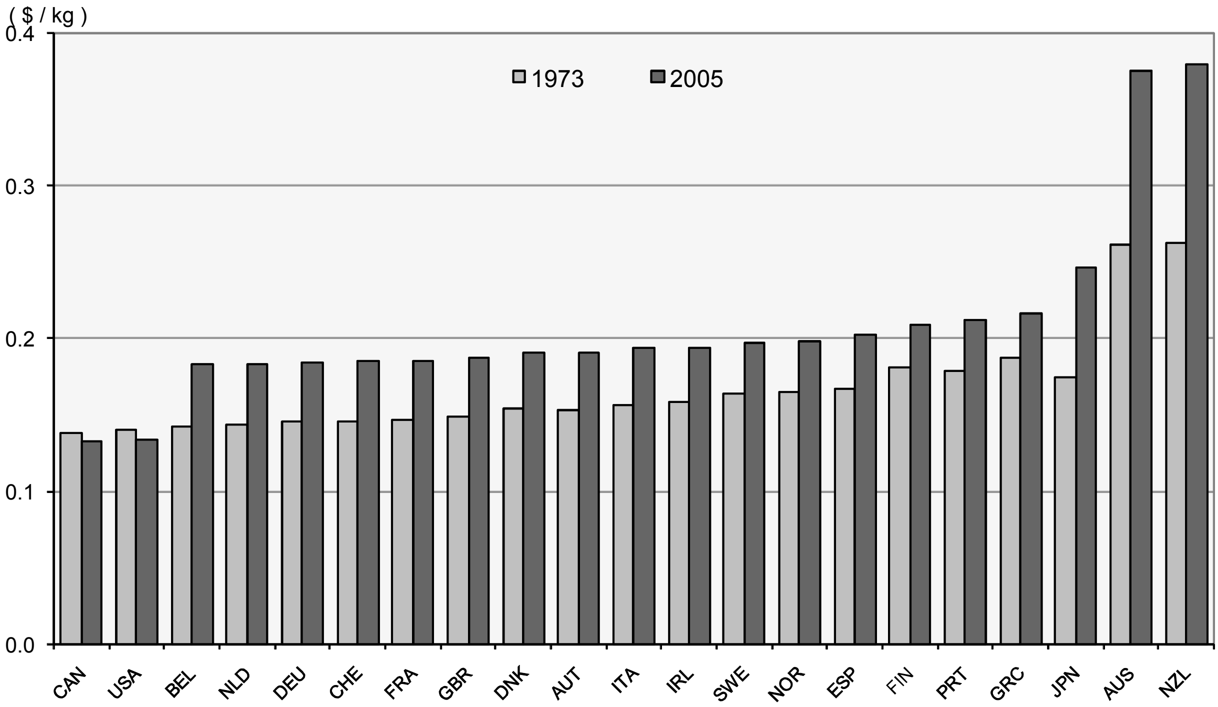


Source: OECD calculations.

46. Figure 11 shows the transport cost results for exports from individual countries for the beginning (1973) and end (2005) of the sample period deflated by the US GDP price deflator. Individual European country costs vary somewhat, due largely to the differing road costs noted in section 4.3. Countries on the periphery of Europe, such as Greece, Portugal, and Finland, have total transport costs about 10-20% above those of the more centrally located countries within Europe, such as France and Germany.

47. Transport costs were also calculated per unit of value shipped as an alternative to cost per kilogramme. If the share of air versus maritime shipments is again assumed constant across countries at a point in time, the use of values rather than physical weight has minimal effect on the cross-sectional variation of transport costs. The time pattern of fluctuations is also similar for the two methods. Given that the weight-to-value ratio of traded goods has declined over time, however, *ad valorem* transport costs fall cumulatively over the sample period, relative to transport cost per kilogramme, by about 30%, reflecting the rising share of goods shipped by air and the much lower weight-to-value ratio for the latter compared to goods shipped by sea.

Figure 11. Individual country real total average transport cost[1]



1. The nominal average transport cost for exports deflated by the US GDP price deflator.

Source: OECD calculations.

5. Concluding Observations

48. This paper presents a first attempt to compute transport costs at the country level based on direct measures of transport costs rather than on cif/fob ratios or other balance of payments data. An analytical framework was derived for aggregating road, maritime and air transport costs at a bilateral or regional level, drawing a distinction between modes of shipping to neighbour and non-neighbour countries. The

results should be treated with caution given the deficiencies of the data. The time trends are also sensitive to the method of deflation.

49. The results show that Australia and New Zealand have the highest transport costs among the OECD countries considered, reflecting their isolation and large distance from other regions. Japan's costs exceed those of Europe and North America in recent years for outbound traffic, but not inbound traffic, reflecting developments in maritime transport whereby the cost of shipping from Asia has risen sharply relative to cost of shipping to Asia. Within Europe there is some variation in transport costs, reflecting primarily the different geographical locations of countries relative to the heart of Europe, and the consequent variation in road transport costs.

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